Space Weather Technical Forecast

Issued on Sunday, 24 April 2022 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Moderate Solar activity likely with further M-class flares (R1/R2 Radio Blackouts) and a slight chance of X-class flares (R3 Radio Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with only small C-class flares observed. There are eight sunspot regions on the disc, the largest and most prominent of these being AR2993 Dkc/Beta-Gamma-Delta and AR2994 Eho/Beta in the northwest, the former arranged such that some north-south shear instability is likely. All other regions are smaller and simpler, although a couple of notable spots include AR2995 Cho/Beta in the northeast, and AR2998 Hhx/alpha near the southeast limb. While this region is currently of a simple unipolar classification, further spots have the potential to rotate onto the Earth-facing disc from around the southwest limb. No Earth-directed CMEs have been observed on available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind speed as observed by DSCOVR and ACE at L1 has increased from 450km/s to be elevated at just over 500 km/s, likely due to an ongoing transition into the fast wind of CH77/+, whilst its density has persisted around average. The Interplanetary Magnetic Field strength (IMF) Bt, persisted at weak levels, below 6nT with the north-south component Bz oscillating between +6nT and -6nT. Phi angle was mainly positive throughout. Geomagnetic activity was Quiet to Active.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at background levels throughout. The high energy electron flux (greater than 2MeV) has been at background to Moderate levels throughout, peaking 534pfu at 23/1320UTC with the associated 24 hour fluence below the Active (1e8 integrated pfu) level. The 24/0000 UTC observation was 1.13e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity likely to increase to Moderate at times through the period, with further M-flares, most likely from AR2993 or perhaps AR2994. There is a slight chance of this increasing to High due to an isolated X-class flare.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on the 21st due to an M9.6 flare from AR2993 has a low chance to give a glancing interaction on day 1 (24th). Otherwise, elevated solar winds day 1 (24th), due to the arrival of the fast wind of CH77, are expected to gradually ease day 2 (25th) and beyond. A spell of Unsettled to Active geomagnetic activity is possible at first day 1 (24th), and again, with any CME arrival. There is a slight chance of G1/Minor Storms. Otherwise mainly Quiet conditions are expected, with isolated Unsettled spells.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the more complex regions on the Earth-facing disc move onto and across the northwestern quadrant. The high energy electron flux (greater than 2MeV) is expected to be at mainly background levels. Electron fluence values are forecast to remain below the Active (1e8

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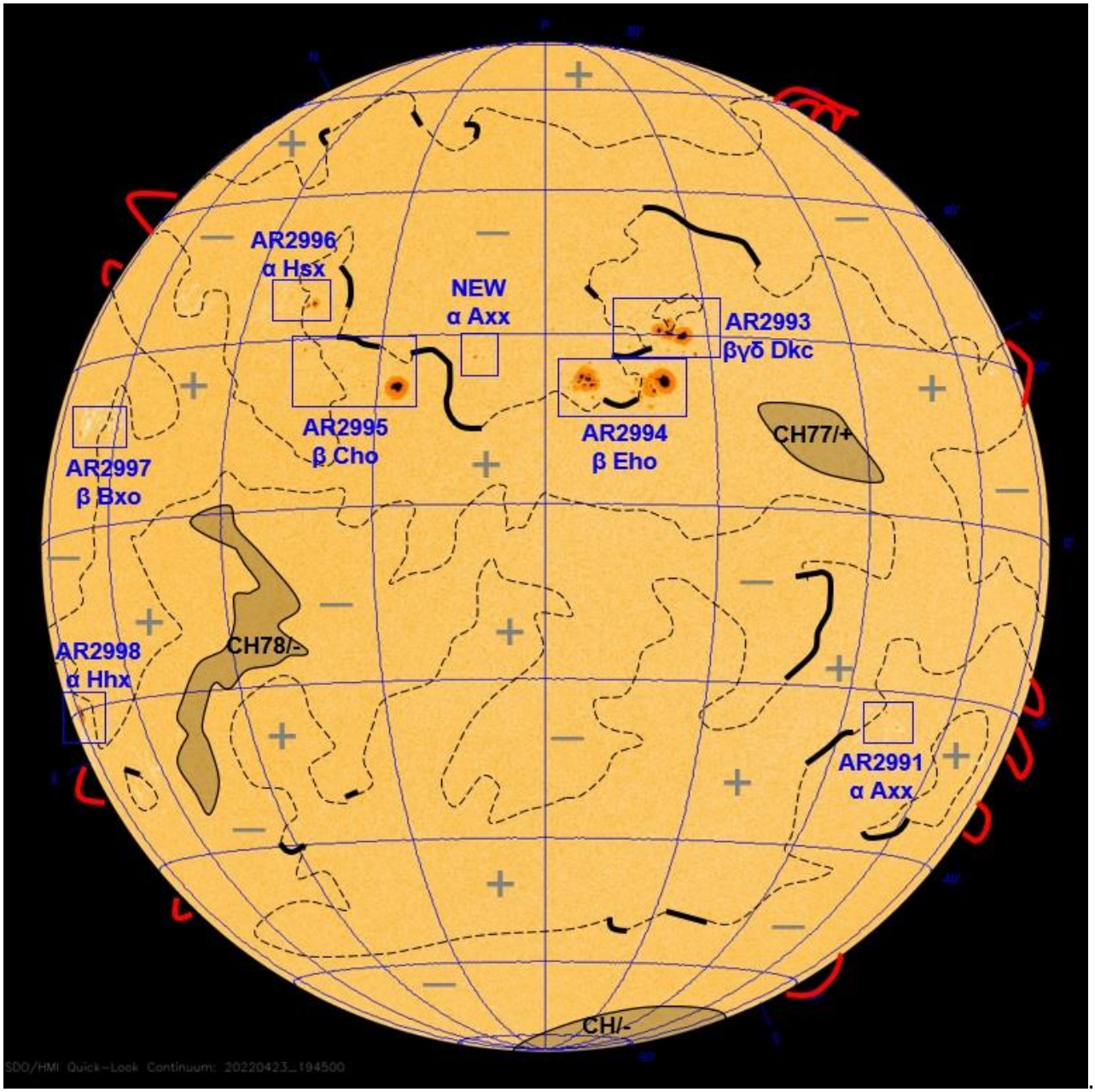
integrated pfu) threshold.

Figure 1. Solar Analysis Valid 20/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on the 21st due to an M9.6 flare from AR2993 is forecast to pass Earth orbit on day 21(24th April), likely missing behind and to the north of Earth, but with a slight chance of a glancing interaction.

Current slightly elevated solar winds have the potential to become further enhanced to become enhanced early day 1 due to the ongoing arrival of the fast wind of CH77/+ which is a northern hemisphere feature.

Geomagnetic activity is forecast to be mostly Quiet with isolated Unsettled intervals. A spell of Unsettled to Active is possible with the arrival of the coronal hole fast wind day 1 (24th). There is a slight chance of a glancing interaction of the CME, also on day 1 (24th), giving a slight chance of G1/Minor Storms. Geomagnetic activity easing again day 2 (25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1245 UTC	Partial	M9.6 of AR2993	N15 E18	420	Missing	Small chance of glance 24/1500 +/- 9 hours

Figure 2: Solar wind persistence Model

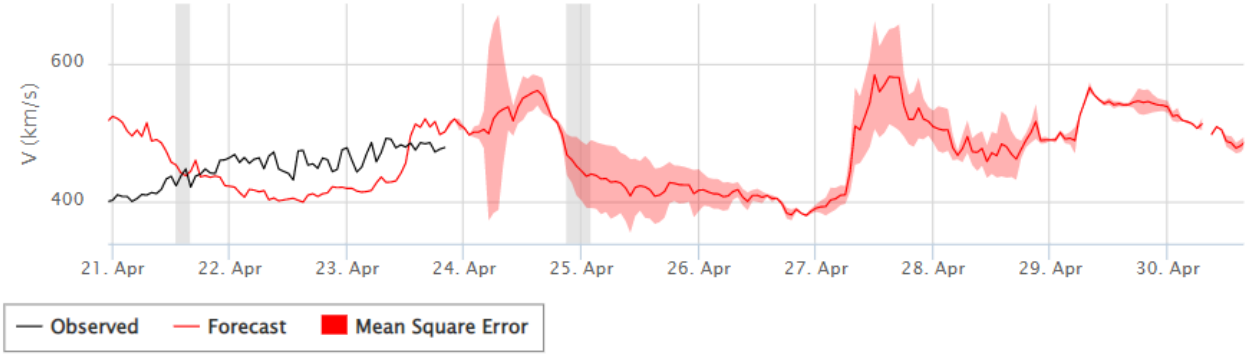

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Figure 3: Enlil showing slight glance possible

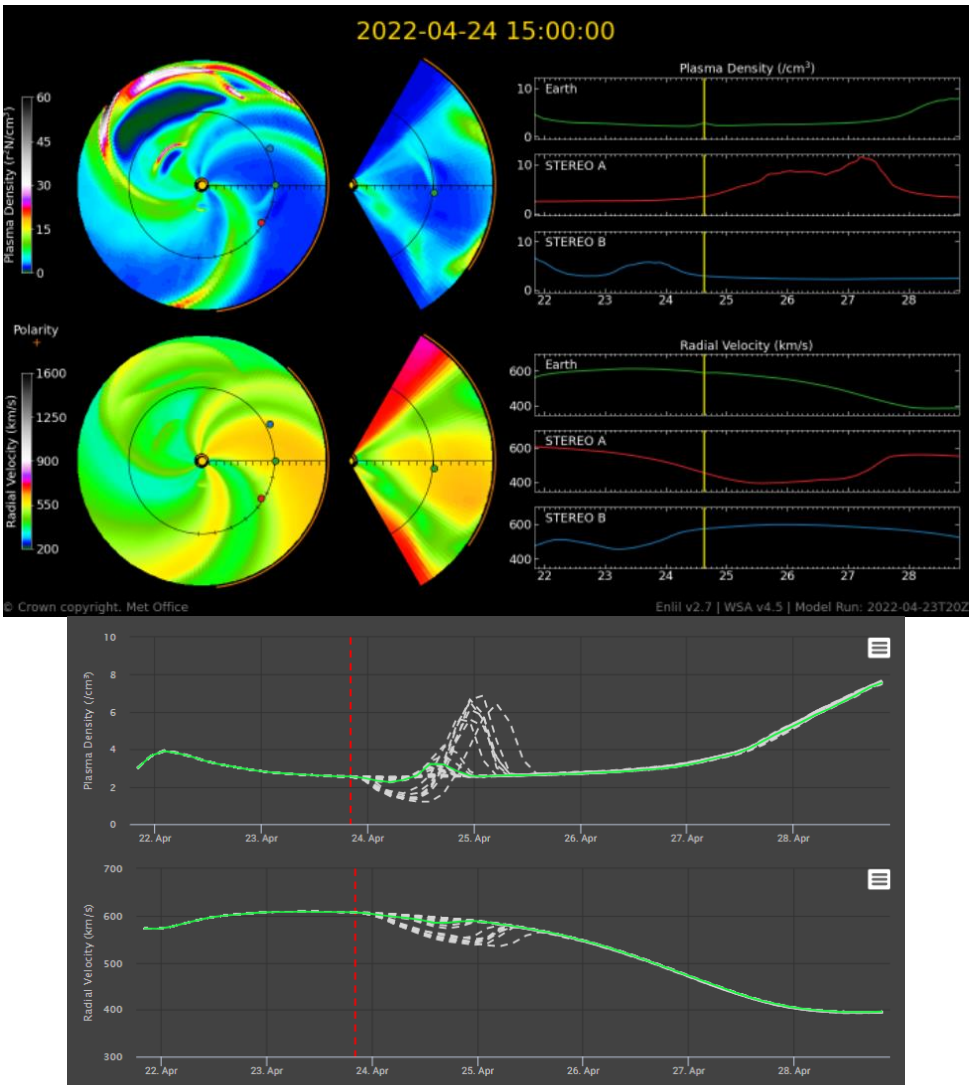
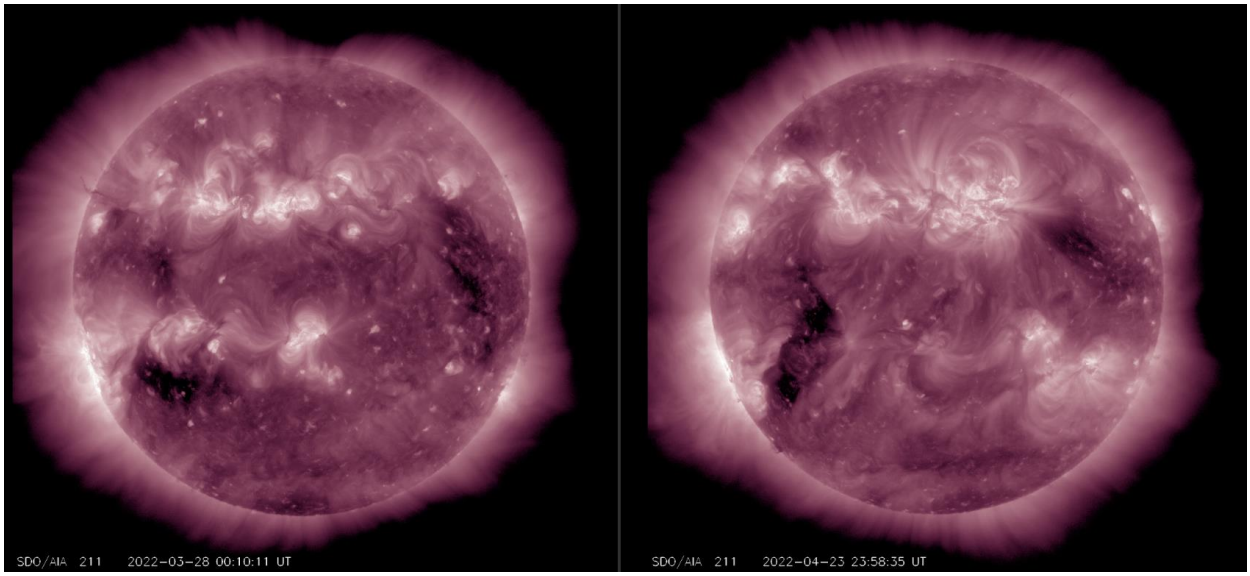


Figure 4: SDO aia 211 of previous rotation (left) and current rotation (right)



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Radio Blackouts - X-Ray Flares:

Solar activity has been Low in the last 24 hours, with only a few C-class fares observed, predominately from AR2993 Dkc/Beta-Gamma-Delta and AR2994 Eho/Beta, both now in the northwest quadrant with some intertwining of their magnetic fields.

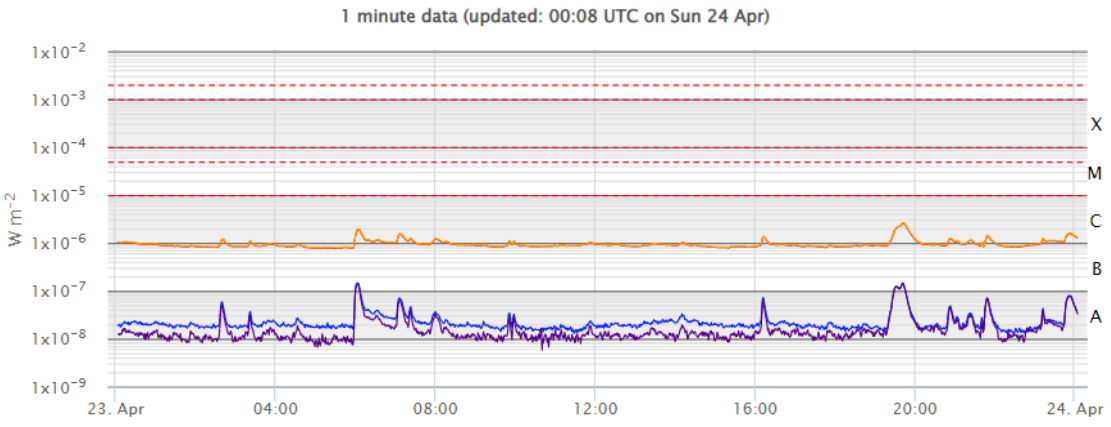
AR2993 is a moderately sized region, and the source of 12 M-flares during the previous week. This currently consists of three distinct positive umbral regions, with the main negative trailer a smaller umbral region to the north, although the spot is also magnetically connected to a spotless negative region to the east. The penumbra of these regions have expanded into each other, albeit with some breaks still evident. Furthermore, its north-south alignment indicates some potential instability from magnetic shear. AR2994 is a larger, but also simpler region primarily consisting of two large separate penumbral regions. Some development has recently been observed to the east of its leader spot however. This region has only produced 2 small M-flares since its X1.1 on the 17th, indicative of its greater stability, however it still has sufficient flux for significant flares.

A number of other small sunspots follow in the northeast, and these all have the potential for further development, the largest of which is AR2995 Cho/beta. A further source of interest is the southeast limb, where AR2998 has rotated onto the disc. This currently appears to be a simple region however the bright signal from this region on STEREO A euvi, suggests the potential for further features to rotate onto the disc.

Activity is therefore likely to increase to Moderate at times through the period, with further M-class flares, and with a slight chance of further X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 5: GOES16-17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is expected remain so through the next four days. AR2993, and perhaps AR2994, bring a likelihood of isolated high M-class to low X-class flares (R2-R3 Radio blackouts), and as they move across the northwestern quadrant there is an increased potential for any solar radiation storms from any such events to be observed at Earth

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 6: SDO Magnetogram and Intesitygram of AR2993 and AR2994

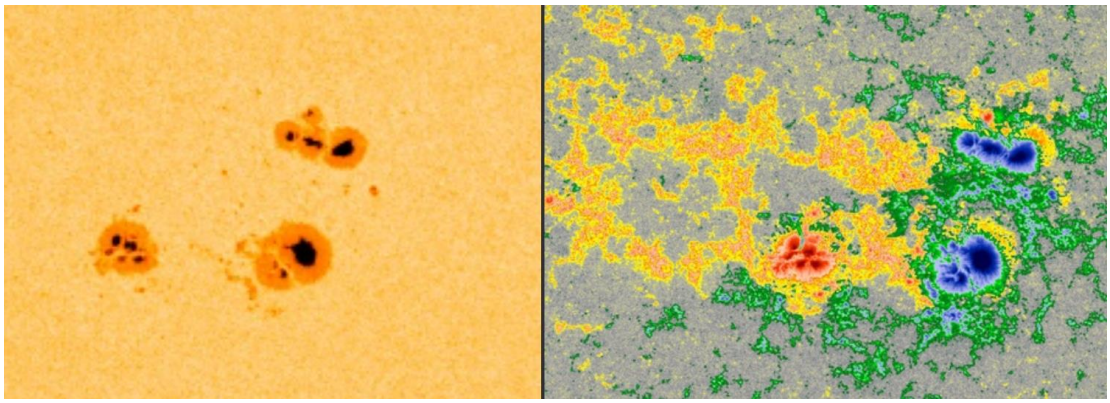
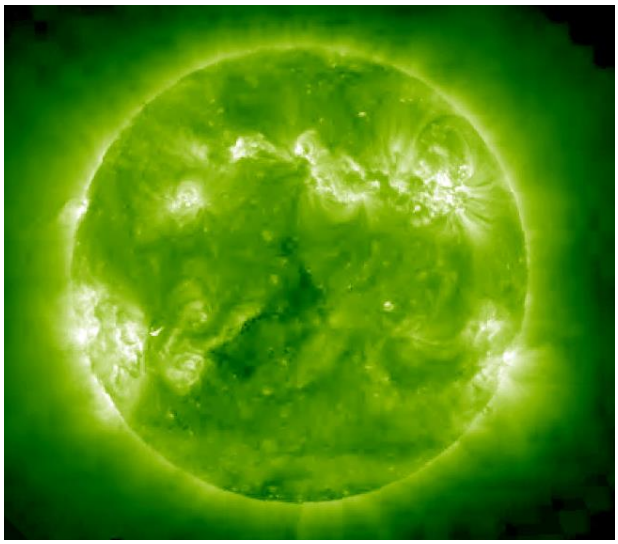


Figure 7: STEREO A euvi imagery showing potential regions to rotate on in southeast



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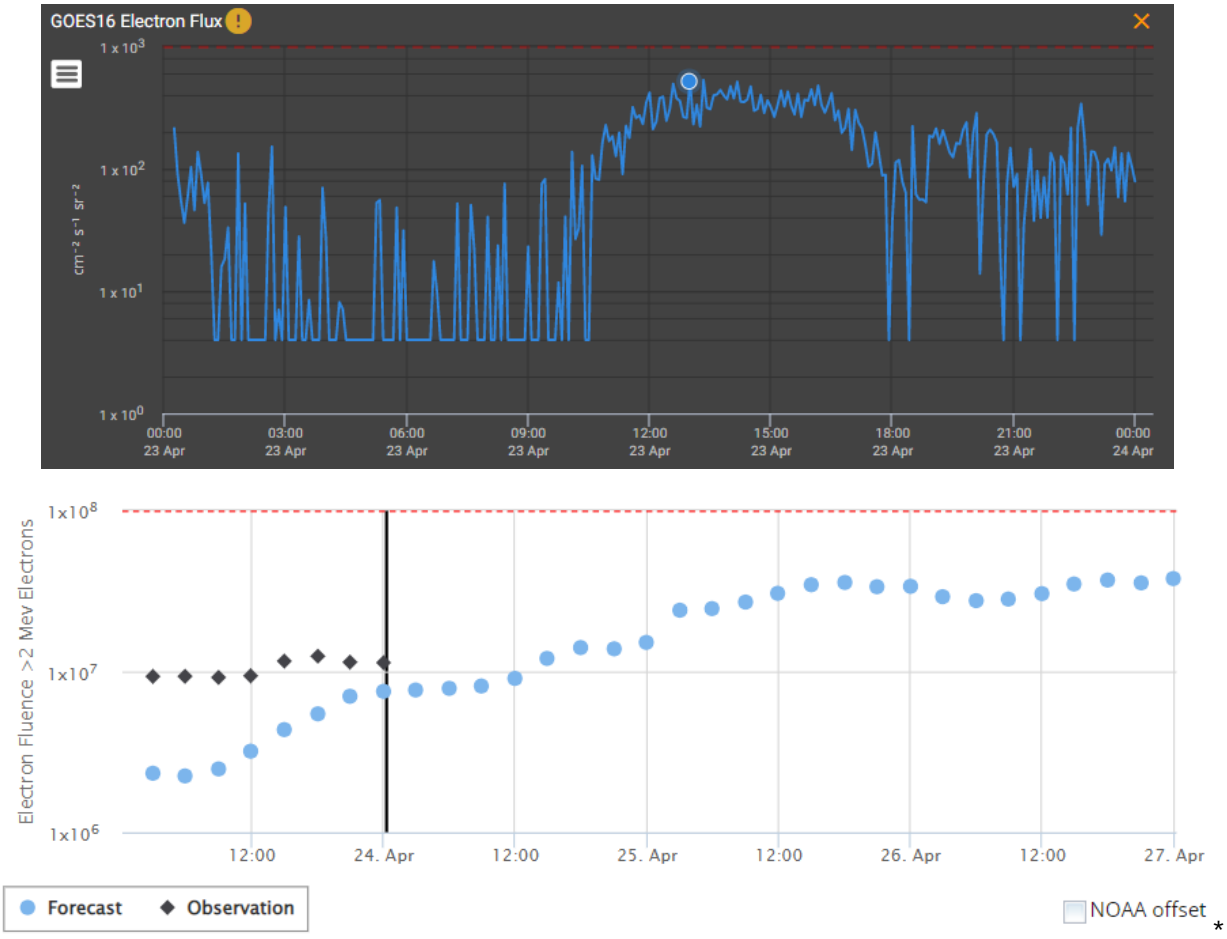
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is expected to be at mainly background to moderate levels. A slight enhancement to the flux is possible day 2 (25th) onward, after the arrival of the fast wind of CH77 and any glancing CME interaction that occurs. This is expected to remain below the Alert threshold (1000 pfu), with a slight chance of rising above during diurnal peak period by day 4 (27th)

The associated 24 hour fluence values are expected to remain below the Active (1e8 integrated pfu) threshold, with REFM currently giving a reasonable guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 8: GOES-16 >2MeV Electron Flux and Fluence with REFM



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